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ECONOMY IN PIPE LINES FOR SMALL WATER SYSTEMS.

E. D. ELDREDGE.*

[*February 11, 1920.*]

The present cost of water-works construction is so great that any details that show a possible saving are worth considering. Let us consider a simple case, that of a small and variable population in a relatively large area of irregular layout of streets. The average summer resort or old-time village comes under this description. Parts of larger towns and cities may sometimes be included. This applies, perhaps, to New England, more than to any other part of the country. The benefit of pleasure and healthful recreation leads many to the country or seashore. Some of the interesting features of such resorts are often the irregular and rambling streets and lanes. The need of better water supply soon arises. It is hardly worth while to install a water system without including a good fire protection available the year round. This calls for a pipe system, in some cases, larger than is needed for the domestic supply alone, nothing less than 6-in. being permissible for hydrant connections. It is the best policy, of course, in cities where the consumption is large throughout the year, and where sufficient funds are available, to use pipes amply large. Cast iron is the favorite pipe. But now in the small town we find many conditions under which a system can be designed with two points in view, one the fire service and the other the domestic. First the location of the hydrants should be chosen, and this with due regard for probable extensions. Then the pipes of sufficient size to supply them should have their best location chosen. Now we come to the domestic requirements, a large part of which is supplied directly from the fire lines. Many houses, however, are in short cross streets or on lanes, a considerable distance from the large mains. In the case of shore resorts the limits of settlement are in some directions confined by the water boundary, where no further extensions will occur. Why should domestic services, if they are at a distance from the fire lines, be supplied from pipes larger than necessary, particularly if they are occupied only during the summer?

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Large lines of cast iron give red-water trouble when the consumption is small and the temperature of the water is low.

The solution is found in the judicious use of small pipe lines connected at favorable points to the fire mains. This composite system will be found amply suffiicient to a surprisingly large extent, if proper pipe is used. Moreover, a small line of wrought-iron threaded pipe, 2-in., 1½ in., or 1¼ in., cement-lined, will not only do the work but will do it decidedly better than a larger cast-iron main, as it is not subject to internal corrosion or tuberculation, and does not produce red water. The experience of over twenty years is the basis of this statement. Pieces cut from a line show the pipe to be in perfect condition. It should be stated that this type of cement-lined pipe is that quite commonly used for individual service pipes, and is entirely different in its characteristics and durability from the old type of 6-in. thin sheet-iron cement pipe, which is being replaced as opportunity offers.

The 2-in. cement-lined pipe is connected to the cast-iron fire mains in various ways, the favorite method being by using a tapped tee in the main or a tapped plug in a cast-iron tee or cross. If the branch is to be connected to a main not provided with such a tee, two or more ordinary corporations may be put in, connected by means of a manifold, having all the iron parts cement lined. Iron-body gate valves are used, also cement lined, except, of course, the brass working parts.

The principal point of excellence in the execution of this work is due to maintaining a continuous and complete cement interior, allowing no chance for metallic iron exposure to the water. This is possible, but in too many cases its use is avoided on account of the supposed difficulties and the care necessary. It is a class of work in which a change of workmen should be avoided. Men become accustomed perfectly to its use.

In most cases a water works requires a few permanent men. At times in the winter there is but little outside work. This furnishes the opportunity for these men to turn to the work of cementing a lot of pipe for next season's use, as is now the custom of a few concerns in the preparation of 1-in. service pipe. The same men prepare the pipe and lay it; thus a certain perfection is attained. In all cases of service pipes direct from the fire mains, the cement lined is used. With the standard work a ¾-in. pipe, lined, is sufficient for the ordinary house service, the pressure being about 45 lb. In good soil, particularly where it is sandy, a rigid connection is satisfactory. Not one such connection has failed out of nearly 900. The corporations are tapped level in the side of the main.

Cement-lined pipe of this type stands all the bending ordinarily needed without the least injury to the lining. For prospective service connections to a cement street main, tees with ¾- or 1-in. plugged branches were introduced at desired intervals, as the pipe was laid. The tees were cemented integral with a nipple about 4 in. long. This nipple, with the

tee combined, was screwed into the coupling on the main, thus avoiding the removal of a coupling and an imperfect joint resulting.

The full lengths of two-in. or smaller pipe are more convenient to line, inspect to insure perfection and to handle, if cut in two. The short lengths give better chances for location of tees, which are placed with some freedom and a record made. Some pieces 4 or 5 ft. long are kept at hand, all with couplings well screwed on before lining. If it becomes necessary to cut a pipe, as for accuracy in locating a gate, a hack saw is always used, to preserve the plane of the cut.

No outside men are allowed to lay any service pipes. All underground pipes attached to the system are laid by the water-works men.

In some localities the ground will permit tunneling, which saves about one half in the excavation, and is perfectly adapted to the requirements of laying threaded pipe in half lengths.

DISCUSSION.

MR. D. A. HEFFERNAN.* I should like to ask Mr. Eldredge in regard to the metal of the 2-in. valve. and lining of the composition part.

MR. ELDREDGE. There is a recess between the brass seat and the end of the thread. On a 2-in. gate there is a space nearly three fourths of an inch, which is cored out larger than the opening of the valve. That space will permit of lining, and will hold the cement all right. When the joint is screwed together the cement on the pipe comes in contact with the cement in the valve.

MR. HEFFERNAN. How are the joints protected where the pipe is screwed together? Is it a fact that you can bring the cement surfaces, of two separate pipes, together, at a joint; or is something placed there after the pipes are screwed together to keep the water away from the iron?

MR. ELDREDGE. It is possible to bring the two continuous linings of cement together. In some cases a brass ferrule has been slipped into the adjoining ends to bridge any space. It is, however, possible to line the pipe with coupling on, and after the cement has partly set, to trim out the coupling, till the lining is at a proper distance within the coupling, so that when the next pipe is screwed in it will butt against the cement already in the coupling. This process works as well in 2-in. pipe as in the smaller sizes. One point that has proved perfectly possible in the service connections is the use of ¾-in. pipe. It is not customary to use pipe as small as that, but it has done all right for twenty years and the ordinary house gets plenty of water through it. It is more convenient to operate, and cheaper and better in many ways, than the inch pipe.

MR. H. J. GOODALE.† What would be the diameter of ¾-in. pipe or 2-in. pipe after it had been lined?

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† Superintendent Public Works, Attleboro, Mass.

MR. ELDREDGE. Three-quarter-inch pipe makes up to about 9/16, and while that size seems a little small the interior of the pipe is smooth, and the friction loss through it is very slight. More water will go through that than through a half-inch galvanized pipe. With a 2-in. pipe the lining is about a quarter of an inch thick.

MR. GEORGE A. KING.* I should like to ask Mr. Eldredge what kind of cement is the best lining.

MR. ELDREDGE. The best cement is the old-fashioned Rosendale cement, — Hoffman, and various brands. In fact, the Portland cement is not satisfactory; the other cement sets more slowly. The process of lining, which most of us are more or less familiar with, is to fill the pipe two thirds full of cement and then draw a plug through it on a wire. The operation possibly has to be repeated, by drawing the plug through a second time, to get a perfect surface. But it is a perfectly practical thing, easily done.

MR. KING. You do not grout it?

MR. ELDREDGE. No, it does not seem to need it.

MR. KING. Mr. Forbes, of Brookline, does.

MR. ELDREDGE. Yes, I know; but it does not seem to need it.

MR. HENRY A. SYMONDS.† Has there been difficulty in getting the cement centered? It may not make a great difference in the efficiency of the pipe, but it seems better to have uniform thickness of cement all around. One superintendent of water works has been able to get concentric lining, by using two sets of fins on the leading plug.

MR. ELDREDGE. There is much less trouble than would be supposed. As I said, we always cut the lengths in two, which gives an opportunity for inspection, to see clear through the pipe. The plug that is used has one set of wings. If the pipe appears all right on inspection, if the cement is continuous, no breaks in it, it is all right. It doesn't make any difference if it is not perfectly concentric. That has been demonstrated upon pieces that have been cut after some years of service and found to be quite eccentric, and still no defect arises.

MR. KING. We had some trouble on account of lining not being centered, the trouble caused by the back end of the plug dropping down, but by increasing the length of the fins we obviated that.

MR. HEFFERNAN. I think that the use of the hacksaw mentioned by Mr. Eldredge is very important. Some mechanics use the regular pipe cutter, with the result that the cement at the end, where the cut is made, crumbles, and later on the water will have some effect on the iron pipe.

For lining the pipe, we use the Rosendale cement. That is a slow-setting cement. The Portland cement is quicker setting, but I do not think you get as good results. We began by lining in 19- or 20-ft. lengths,

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† Civil Engineer, Boston Mass.

the ordinary length. The inspection could not be made properly, so that we now cut the pipe in two to give us a chance to inspect closely. The regular cone or plug which was used to go through the pipe came in the original two sections, and we found that it was more or less difficult to get a smooth lining; in fact, we did not get it. And so we had the manufacturers make a cone 2 ft. long, which we now use, and it gives good satisfaction. If anybody does have any trouble, if he will try a cone about 2 ft. long and use the Rosendale cement, I think he will get a perfectly lined pipe.

MR. JOSEPH A. HOY.* Our pipe will average anywhere from 20 to 21 ft. in length, and our process in Worcester is to ream the ends out and then put the rods through, practically the size of the inside diameter of the pipe. We place them in the cellar, and mix the Rosendale cement. The same man usually does the mixing. Our cone has fins on it and a follower attached. It may be necessary to fill two or three times after the cone has been pulled through. A lamp is then placed at each end. The operator looks, and if he sees that there is a place that has not picked the cement up, he puts in a little more and pulls the cone and the follower through again.

Can you tell me approximately how many feet you will line in an eight-hour day?

MR. ELDREDGE. Well, it would vary somewhat, but we expect to line 500 or 600 ft.

MR. HOY. We line in an eight-hour day — three men working — from 900 to 1100 ft. That is either 1-in. lined to ¾ in., or 1¼ in. lined to 1-in. We also line the couplings, but, as Mr. Heffernan said, you may start the cement in the couplings. If you line the inside of the pipe up to the thread you are going to grind some of the cement off. I think the surest way is to put a little cement in the coupling, screw it on the pipe, have your cone in place, and pull it through. Then it all depends upon the weather, whether you ought to put a little powder around and start a fire to harden it up, or whether the water is going to be turned on right away and flush it out again.

MR. HEFFERNAN. It may be well to know that the lead-lined coupling is a very useful coupling to use. We use lead-lined couplings, and they give a perfect joint, as there is no danger of cement crumbling where two joints come together, and we are sure of getting the joint tight. Does any trouble occur from the cement coming out of the coupling? We have had that difficulty, but the lead-lined couplings entirely eliminate the possibility of the cement being broken out of the couplings when the pipe is made up.

MR. SAMUEL E. KILLAM.† I have not been very successful in bending cement-lined pipe. That is, my foreman thought he had been, but I

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† Superintendent Pipe Lines and Reservoirs, Metropolitan Water Works.

insisted that it be taken out and cut, and found that the cement was cracked away from the pipe. How much can you bend a 10-ft. length with safety?

MR. ELDREDGE. You can bend a 10-ft. length 10 or 15 degrees. You can perhaps do better than this if you make the bend with a sufficiently long radius and do not confine it to one spot. It is difficult to explain, but for some reason a very considerable bend can be put in without injuring the cement.

MR. PATRICK GEAR.* Do you have any trouble where the cement might break, and then go through and get into the meter?

MR. ELDREDGE. I never knew of any breakings where the two ends screwed together. They might grind some of it off, but it doesn't come off in the form of chips but in the form of powder, and the first operation of cleaning the pipe, blowing through, removes that, and there is never any more.

MR. HOY. After your pipe is lined, Mr. Eldredge, — after it is practically baked in from standing there, — do you run a thin grouting through and pull a rubber follower through it to cover up any little spot that you might have missed in the process of lining?

MR. ELDREDGE. No, we do not, for the reason that the third man, or inspector, discovers any defects. We do not allow any to pass that has any defect in the cement, but put a little more cement in and run the plug through again.

From some of the questions that have been asked it seems that it is not always the custom to use an extension on the pipe in the process of lining. On both ends of the pipe it is best to screw a nipple about 15 to 18 in. long, and let the plug enter and leave from those nipples. That is where unavoidable roughness will occur. The pipe that is between the two nipples will have a perfect surface.

MR. HOY. On the finishing process there we mix a thin grout. We pour the grout in and have the pipe on an incline, then bring the pipe up practically to a level and pull a rubber cone through, which practically takes off any little blisters there may be or cover any spots which were left.

MR. ELDREDGE. I think that is quite a common method and doubtless is an excellent system, but it is just one of those points that whatever method you get started on you can develop in one direction, while some other person develops in another direction.

MR. HEFFERNAN. Do you, Mr. Eldredge, ever figure the cost of lining 1¼-in. pipe to 1-in.; also, is the pipe given a coating — where the wrought-iron pipe is galvanized?

MR. ELDREDGE. We use principally the black wrought-iron pipe, although some galvanized. If the pipe is to be put in any place where the ground is wet or in the neighborhood of salt water, we would use galvanized. In one case where a 2-in. pipe was laid near a salt beach, a rough

* Superintendent Water Works, Holyoke, Mass.

coating of cement was applied on the outside after it was in the trench, to protect it from the salt water. That pipe was opened ten years afterwards and found to be in perfect condition. When the pipe is trimmed out, finished, and all defects at the ends corrected, the last operation is to give it a coat of asphaltum paint and put a little oil on the threads. The threads are always inspected.

As to the cost, it is rather a variable quantity. It is not always possible to figure the actual cost, for the reason that it is a job that can be done while wages are still going on, and it does not add anything to the cost of the pipe. It is usually not a very expensive part of the business.

MR. HEFFERNAN. We line our pipe during the winter, when those men are doing nothing else. A certain charge per foot to the consumer must be made. Have you adopted a plan, Mr. Eldredge, of charging so much a foot for the pipe and so much for the digging?

MR. ELDREDGE. Yes.

MR. HEFFERNAN. What do you charge for the inch pipe per foot?

MR. ELDREDGE. We charged 15c a foot for the ¾-in. pipe up to last season. The price is a little higher now; last season for inch pipe we charged 18c. That did not include the cost of laying, which varies with conditions. Two or three cents a foot would cover the expense of the cement lining of the smaller sizes.

PRESIDENT MACKSEY. It is interesting to note that the discussion of this paper has been on the detail and not on the general principle, and I think the general principle is one to which we should give some study. The question is, whether we can go on as many of us are doing, putting in large cast-iron pipe, 6 in. in diameter, where there is a call for water which might be supplied through a pipe of 1 or 2 in. diameter. It is true we are building for the future, but can we afford to go on doing so? There are so many things to pay for in water-works service at this time. The cost of everything connected with the water-works construction and service has increased about 100 per cent., whereas the selling price of water has gone up not more than 25 per cent.

Is Mr. Eldredge right in saying that we should in very many cases neglect, for the time being, the growth of the district we are about to supply and provide no fire protection? If water service is paid for by the municipality, the municipality as a whole demands water service for practically everybody, and unless you have a board of survey in your city or in your town some real estate speculator may buy up a farm, or a lot of waste land, and cut it up into building lots which look beautiful as shown on the blueprint. He has utilized every square foot of his land, and has given you all the street fronts that it is possible to give with the limited amount of land which he has. In many cases you find that the development is such that it is a criminal waste of money to lay water mains through the alleged streets which have no proper lines and grades. If you give water service to-day, you may find that in the future either

your pipe will be near the surface, perhaps above ground and liable to be frozen, or buried so deeply that it is difficult to find when there is a break, or when a service connection is to be made.

It is a matter which every superintendent and every man responsible for the financial condition of water companies should carefully consider: shall we supply just what is actually needed to-day or shall we supply fire protection also; shall we build for to-day only or for the future? That is the main thought in Mr. Eldredge's paper, which should be discussed. We should all bear it in mind when we are developing any works with which we are connected.

MR. SYMONDS. I feel that Mr. Eldredge has presented a subject that we hardly realize the importance of at this time. We are at a point where we have got to change a good many of our views as to the apportioning of mains for supplying water. Within the last six months a Massachusetts town has had a complete design made for a water-works system, and entirely eliminated the question of fire protection. It is unfortunate that such action is necessary, but when it came to actually figuring the expense of a fire protective system it became evident that it would be excessive.

In the past it has usually been, in communities of substantial size, a very easy matter to show that a large saving in the insurance rate would result from the installation of a suitable system. In a case which has come to my attention in the last week I attempted to figure out and prove by the old method, allowing what seemed to be a fair amount of insurance to be carried in that particular community, taking the rates furnished by the New England Insurance Exchange for the class, for unprotected service, and then the saving which would be occasioned if a protective service were provided by such a plant as would naturally be installed. I was rather disappointed and somewhat surprised to find that no showing at all could be made for a fire protective system as a financial proposition. It was going to cost twice as much for a hydrant rental, which would be a fair rate as would be saved. Of course, there are other features to be considered than the mere saving in insurance rates. But that ratio has been dwindling until we must look at it from a very different point of view.

I hope the time has not arrived when we must design plants for fairly good-sized communities and leave out the fire protection; but I must admit that as a business proposition we have got to cut out the fire protection in many places where it has been entirely practicable and a good business proposition to install it previously.

MR. LEONARD METCALF.* Mr. President, I had not thought of speaking on this subject, but it occurs to me to suggest that we should differentiate between the different classes of problems that come before us. I am in sympathy with the idea that in many of our extensions in the

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smaller communities, and in the real estate additions such as our President has referred to, we may well adopt temporary expedients in the light of present prices. On the other hand, when we come to consider the question of adequate service for our larger communities and cities, it does not seem to me that there can be any doubt that it is the wiser policy to continue to build for the future rather than to take the danger and risk which go with the more modest scale of construction.

I met that very problem at Dayton during the war. The works were carrying a burden which was really beyond their normal capacity, — that is, the margins of safety had been used up. They were drafting from a driven-well supply, where they had a fluctuation in ratio of demand of about 5 to 1. Their consumption was perhaps about 15 000 000 gal., from 12 000 000 to 15 000 000, and their maximum draft for short periods of time was up to a rate of 35 000 000 gal. per twenty-four hours. That was a very serious tax on the wells. One of the methods suggested for obtaining relief was to build reservoirs on the hilltops surrounding the city, but the city, of course, was put to it for money, — it was in a very difficult position. It would have built under normal conditions three or four of these reservoirs, probably of 20 000 000 gal. capacity each, but after studying the question I advised that they build one reservoir of 10 000 000 gal. capacity, with proper connection to the distribution system. That ironed out this heavy peak demand upon the wells, and it gave enough water in storage, not only to take care of the fluctuations in demand, but also to take care of serious fire. The city fathers, when they came to discuss the matter, said, " Can't we cut this reservoir to, say, 3 000 000 gal.? " I said, " Yes, of course, you can; but in my judgment you should not; consider the other side of the ledger; you are doing millions of dollars of work in this city for the Government in munition's manufacture, and any interruption of the service resulting from conflagration would be a very serious matter; it does not seem to me that it is wise, for the sake of saving $100 000 or $200 000 on the entire enterprise, for you to take that risk; do it if you please, but do it with your eyes open, recognizing the risk which you are taking." Of course, they appropriated the money and built the larger reservoir, and they are going ahead to-day with important extensions, believing that the risk to the city without margins of safety is too serious.

It is not simply a question of saving in insurance; there is also involved the question of the interruption of the industrial life of the city, and that may be, of course, a very serious matter. I can't help believing that a good deal of our trouble is from not yet having bridged the gap between the old and the new conditions, the effect of disbursement of very large sums of money for war purposes and the great difficulties of our cities in making good the loss of income which they used to get from the liquor licenses. But in spite of that it does seem to me that the really essential work — that is, work which is essential to the maintenance of a high

standard of service — in the industrial district, the commercial district of the city, and the more important residential districts of the city — ought to be met. In other words, that we ought to continue to furnish good service.

Now, even though we have lower prices again — of course, they will never again return to the old figures — we must not overlook the side of the risk which we are carrying in not building adequately during this trying period to meet the future. And when we stop to reflect upon the life of the community, it seems to me that we must admit that the water supply is of fundamental importance. There is no other service of a public nature which is so supremely important to the life of the community as the water supply. Moreover, there is no other service which is so cheap, even at present-day prices, as the water supply. So that I incline to the view that in many of these cases we should screw our courage up to meeting the situation as it is and not go on carrying the burden or risk involved by several years of arrested development. Of course, in the case of the private works that are face to face with the inability to get any increase in rates, — if such there be, and there are some such, — I know the problem is a somewhat difficult one. But even there I think the effort should be made to see whether some means cannot be found for bridging the difficulties so that the service may be bettered in spite of abnormally high prices.

There is another aspect of the matter which I think is of importance to the private water-works plant; it must be careful from the point of view of valuation of the effect of this arrested development and of the effect of not building at all during the higher-price period. These works will ultimately be valued on the basis of the cost to them of rendering the service. They will be in a safe position financially if they have gone ahead with your problem, if they have records of the present-day costs, as well as of pre-war costs. A very grave injustice will be done to them, on the other hand, if pre-war costs are used as the basis of valuation or rate determination, under present or future conditions.

President Macksey. The main thought in the paper as read by Mr. Eldredge has been discussed now, while not at great length, certainly very thoroughly.

The thought came to my mind after listening to the discussion, of what effect the laying of small mains has on insurance rates, and in this connection it would be well for every superintendent to get a copy of the detail sheet showing him how he has been rated by the underwriters. I have no doubt that the underwriters have tried to be perfectly fair, and in many cases they did very thorough work, but they cannot always do perfect work, and there are many times when a discussion of the details of their rating would show that they have charged up against the water department deficiencies which are not justified. I am inclined to think, too, — but it is only an impression which I am unable to prove by figures,

FRANK E. WINSOR.
JUN 13 1929

— that the insurance man's wild fear of a conflagration is making many an honest man pay hundreds of dollars year after year when he has no risk. That is something that we water-works men cannot prevent.

There is another side to this fire protection. A man builds a factory in a city where the municipality owns the works. Of course the taxpayers want the city to grow. They want new factories; they want their local men to invest their money at home and employ local people — they want to do all of these, and thought the factory might be properly supplied with a 1-in. pipe. But in order to compete with others he must have insurance; in order to compete with others he must get the most favorable rate; in order to get the favorable rate he must have hydrants and sprinklers. The sprinkler man demands a 6-in. connection to the sprinklers. I have recently put in connections to factories in order that they might have the required fire protection, not to prevent the destruction of their works, because in these cases if a fire starts, sprinklers will not stop it, but in order that that owner may get an insurance rate which will let him do business profitably. The water works of the city invests a thousand dollars in each of those services. There is still another case where, if the main is not laid now, with three feet of frost in the ground, the owner, and men who wish to work for him, must endure great hardship. There are loads put upon water works which consumers do not allow for, when told, " Your water rates must be increased."

If the water department is concerned not solely with supplying water for domestic consumption, not solely with supplying the necessary water for fire protection, but supplying what is necessary to prevent the underwriter from swinging a heavy club on the ambitious manufacturer, somebody besides the man who is buying water for domestic use should pay the cost of each of such installation as maintenance of service. [*Applause.*]

THE EFFICIENCY OF PIPE JOINTING COMPOUNDS AS COMPARED WITH LEAD.

FRED O. STEVENS.*

[*Read March 10, 1920.*]

The great difference in cost between lead and the non-lead joint materials makes it an obligation on the part of water-works engineers and executives to satisfy themselves as to the efficiency of the non-lead products. Although these materials have been in the market for about sixteen years, and have been used in increasing quantities during that period, they are still regarded by the great majority of water-works men with more or less skepticism.

The facts of the case are that lead has proved to be such an excellent material for joints, and workmen have become so well trained in its use, that engineers and superintendents have naturally and rightly hesitated to substitute for it a substance with which they are unfamiliar, and upon which there is a relatively small amount of data as to its efficiency.

The writer has used the two substitutes known as "Leadite" and "Lead-Hydro-Tite" for over eight years, in various localities and under varying conditions, with very satisfactory results, and as a consequence has acquired a great degree of confidence in them. The water-works profession, however, must be, from the very nature of its work, very conservative in adopting untried methods and materials, and is bound to demand something more than the testimony of a few of its members that a certain thing "works all right, as far as they know."

The purpose of this short review, then, is not to take a partisan stand in favor of any joint material, but to impress upon the members of the Association the fact that these substitutes for lead are worthy of careful consideration and investigation in view of the present prices of lead and labor. It is to be hoped that a general discussion may bring out some new facts and stimulate further investigations.

To the manufacturers the writer would suggest that, having now established the comparatively low cost of their products in the minds of the water-works trade, they devote more energy to experimental work, to enable them to answer with definite figures the questions to which a thorough and thoughtful water-works man must have an answer before making what would otherwise appear to him a hazardous change.

The most important of these questions are as follows:

(1) How do joints of these materials compare with those of lead as to tightness under normal conditions?

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(2) What of the possibility of blown joints under high pressure due to water hammer, etc.?

(3) Will the joint have sufficient strength to resist stresses due to bending moment when support is removed from a considerable length of pipe as a result of settlement of back-fill or nearby excavations for services, etc.?

On the first question the writer is able to submit evidence derived from actual experiment. In the summer of 1917 the Weymouth Water Works laid 3 400 ft. of 8-in. pipe, from which no services were taken until the following season. The joints were of Lead-Hydro-Tite, and the new gate controlling this line was by-passed with a 5/8-in. Empire meter testing 99 per cent. in 1/32-in. opening. For the final measurements the flow was too small for accurate measurement by meter, and a force pump was used, pumping from a pail into which water was fed by a standard gallon measure. The results as to leakage per linear foot of joint are shown in the following table, and would, according to available data on the subject, be considered excellent for lead joints.

TESTS FOR LEAKAGE FROM LEAD-HYDRO-TITE JOINTS, IDLEWELL EXTENSION, NORTH WEYMOUTH, MASS.

Date.	Section.	No. of Joints.	Gals. per Minute.	Gals. per 24 Hrs. per Lin. Ft. of Joint.	
1917.					
July 26	1	75	3.375	26.20	New joints.
*Aug. 8	1	75	.150	1.16	
Aug. 20	2	180	.322	1.04	Sec. 1 plus 105 new joints.
Aug. 25	2	180	.305	.99	
Sept. 29	2	180	.217	.70	
Nov. 2	1	75	.041	.32	
Nov. 2	2	180	.098	.32	
Nov. 2	3	250	.495	1.15	Sec. 2 plus 70 new joints.
Nov. 2	4	335	3.500	6.16	Sec. 3 plus 85 new joints or entire extension.
1918.					
*June 1	4	335	.150	.26	

Pipe was 8-in. Class E., New England weights. Average pressure, 70 lbs.
Leakage measured by 5/8-in. Empire meter, registering 99 per cent. on 1/32 in. opening at 70-lb. gage pressure.

* By pump and gallon measure.

This work was done by a man having one season's experience with Leadite, exercising the ordinary degree of care usually required by the writer on this class of work, and the results should give a fair indication of the degree of tightness to be expected under average conditions.

As to the matter of joints blowing out, the writer can only say that he has never known of a Leadite or Hydro-Tite joint blowing out. In fact the strength of these materials and their adhesion to the metal as demonstrated when a joint is dug out seems to be sufficient evidence of their safety in this direction without extensive experiment.

As to the behavior of this type of joint when subject to crushing stresses such as occur when portions of a pipe line are left unsupported by the settlement of backfilling, the writer has been, until very recently, in doubt; in fact, uncertainty on this one point has prevented him from giving these materials his unqualified endorsement as substitutes for lead. This doubt has been pretty much dispelled by the results in a case that has recently come to his attention.

The Berlin Water Company, of Berlin, N. H., built last year a new dam from which an 18-in. cast-iron main was to lead to the city distribution system. About two lengths of this pipe were in the dam, and on the end of the first length on the down-stream side an 18-in. valve was placed. Joints were all of Lead-Hydro-Tite. Before any more pipe was laid the reservoir was filled, and some time later a washout occurred which completely undermined this length of pipe, leaving it and the gate suspended in the air and supported solely by the material in the joint near the masonry. Just what the maximum stresses were in the joint it is neither easy nor necessary to compute, but it seems to the writer that they are as great as are apt to be encountered under ordinary working conditions.

The writer has not attempted to take up the methods of using these compounds, or the minor difficulties attending their use for the first time with inexperienced men and incomplete equipment. These points have been covered in previous papers before the Association and in the literature with which the manufacturers keep us abundantly supplied.

It does unquestionably require considerable courage and considerable faith to give up the good old lead and substitute these new materials in the face of the inevitable opposition from calkers and doubt as to the outcome of the first day's work. The point that the writer wishes to make and to urge very strongly, however, is that we water-works managers and engineers cannot, with a clear conscience, go on using and specifying lead, if these other substances are safe and suitable substitutes. And it is "up to us" to find out whether or not they are safe and suitable, or to make every possible effort to find out.

The bulk of the evidence, so far, all points in one direction, — in favor of the substitutes. In the discussion that is to follow, let us hear from the other side, — the unsatisfactory experiences which, for our present purpose of getting at the truth, are perhaps the most valuable of all.

Discussion.

E. E. Wall* (*by letter*). The St. Louis Water Division has on several occasions tried other materials than lead for making cast-iron pipe joints. The first experiment, of which no record was kept, was made in 1907, although it is remembered by old employees that experimental joints were run with some patent compound before that time, which presumably proved unsatisfactory, as no record was made of their cost or efficiency, and no further consideration was given that material.

During the year 1913 a line of 6-in. pipe was laid in Fair Grounds Park, a connection being made to the city main in Natural Bridge Road, west of Grand Avenue. The pressure at this point is approximately 35 lbs.

The joints on this particular line were made with Leadite, and so far as reported, have not given any trouble nor has the line required any maintenance since it was laid. The use of Leadite was purely an experiment, and it was thought at the time, after trial, that it would not be easily adapted to local conditions.

Leadite is a material which requires a very definite heat for melting to proper consistency, and it was found difficult, if not impossible, to control the temperature by means of a coal fire built around a melting pot as was used on pipe-laying work at that time. The tendency seemed to be to have the fire too hot, which caused the Leadite to burn. Trouble was also experienced by the men pouring the joints, in that the fumes would rise from the pouring pot directly into the faces of the men. This condition seemed to be particularly bad by reason of the fact that the trench in which the pipe was laid was narrow and deeper than the ordinary trench for 6-in. pipe.

Unfortunately, no figures were kept on the cost, but there seems to be no doubt, but that if properly used by experienced men the cost could be reduced below the cost of the ordinary lead joint.

Joints made of Portland cement were used on about 800 ft. of a 6-in. pipe line laid in 1917 to supply Camp Galliard, a temporary recruiting station for a regiment of engineers, afterwards the 312th Engineers.

From the 12-in. main for a distance of about 150 feet, the 6-in. pipe joints were made of lead, because the pipe was crossing a highway and also passed under the track of the water works railway, and it was assumed that any and all vibration or shock would be less liable to produce leaks with lead joints than with more rigid ones made of cement.

The cement joints were made by employees, who had formerly had experience in such work for the gas company, who have laid all of their smaller mains here for years with cement joints.

No leaks developed, and the joints showed no deterioration or checking when the line was taken up a year later. The water pressure ranged from 90 to 120 lb. per square inch.

* Water Commissioner, St. Louis, Mo.

It was found that one bag of cement made 18 joints, and each joint required twice as much jute as a lead joint. Three men mixed and made 8 joints per hour.

Two men can attend to lead pot, make rolls, run and calk ten 6-in. joints per hour.

Actual cost of making 66 joints of cement in 1917:

4 sacks cement @ 43¾c.	$1.75
16½ days' labor @ $2.42	39.93
8¼ days' labor @ $2.10	17.32
82½ lb. jute @ 8c.	6.60
	$65.60

Estimated cost of making 66 joints of lead at 1917 prices:

792 lb. lead @ 7c	$55.44
6⅔ days' labor @ $2.42	15.97
6⅔ days' labor @ $2.10	13.86
41¼ lb. jute @ 8c	3.30
	$88.57

Cost per joint — Cement, 98c.
Lead, $1.34.

Cost per lineal foot of pipe — Cement, 8⅓c.
Lead, 11⅛c.

When this line was taken up in 1918 it was found to be much more trouble and expense than taking up pipe laid with lead joints. The method finally adopted was to place a strong iron collar back of the bell of the end pipe, so that jacks could be placed on the sides of the pipe to operate between this collar and the bell end of the next pipe. The cost of taking up this pipe line was 9.7c., while the cost of laying was 5.7c.

In 1918 about 1 200 ft. of 6-in. pipe was laid, the joint being poured from a new compound called "Metalium." After the pipe was laid the trench was left open for about two weeks to note the leakage, which was measured through a small meter. This leakage, immediately after the pipe was laid, amounted to 2½ gal. per minute, the average during the first twenty-four hours being 1.3 gal. per minute, which was reduced to an average of 1.15 gal. per minute during the second twenty-four hours. In the course of the two weeks before the trench was filled the leakage stopped altogether.

Joints made of this compound did not in this case prove to be as cheap as those made of lead. This may be due to the fact that our men were unfamiliar with handling the material. The indications are that the difference in cost between Metalium joints and those made of lead would be too small to make it any great inducement to us to use the compound on a large scale.

The last three lengths of pipe laid on this line were laid on a sharp up-grade, the rise being 3 ft. in 36 ft., the change in grade being made at one joint. Afterwards this pipe was lowered while under pressure and this joint was closely watched during the process of lowering, but no leakage was noticed and no damage to the joint was observed.

For fifteen years milk of lime, at a temperature ranging from 80 to 130 degrees Fahr., was pumped through a 6-in. cast-iron pipe from the coagulant house to the delivery well, a distance of about 700 ft.

A great deal of trouble was experienced with leaking joints caused by expansion and contraction. In 1919 a new line was laid with cement joints.

The joint was calked with yarn, as in a lead joint. Cement was mixed neat, rather dry, and tamped in the joints by means of a calking tool. The calking was carefully done, and continued until water came to the surface of the cement joint. The joint was continued on the outside by being built up to the outside diameter of the bell of the pipe and sloping down to the barrel of the pipe at an angle of about 45 degrees. This was troweled to a smooth finish, neat cement also being used.

This line has been in service for several months, and has given no trouble on account of leaking joints.

The only leak that has occurred on the line was found on examination to be due to a transverse break in the pipe about 18 in. from a joint. The pipe was pulled completely in two, the nearest joint being entirely intact and uninjured. Evidently the break was due to contraction in the line caused by temperature change.

Mr. R. C. P. Coggeshall.* We laid some short sections of the pipe in New Bedford, with joint compound, and to my knowledge there has been no difficulty with it; therefore it has been pretty satisfactory. This coming year it is proposed to do considerable work there, and Mr. Taylor, my assistant, has taken up the question of the adoption of Leadite in preference to the lead joints, and I think is ready to adopt it. I think perhaps it would be interesting to hear what his plans are in that regard.

Mr. Stephen H. Taylor. I plan to make some experiments with practical joints before deciding what to do. We have not yet made those experiments, but hope to in the future. That will demonstrate the efficiency or the inefficiency of the joint to us.

Mr. Lincoln Van Gilder.† In the old days, when the Atlantic City Water Department was run by two different franchise holders, all joints were laid with lead, but about 1901 Mr. William C. Hawley, now in Wilkinsburgh, Pa., began the use of Leadite. He was followed by Mr. Allen, his successor, and by myself. We now lay with Leadite almost exclusively. We have had no difficulty in carrying pipe along trench lines, and as our contractors are not always careful, the pipe gets pretty heavy punish-

* Superintendent of Water Works, New Bedford, Mass.
† Superintendent Water Works, Atlantic City, N. J.

ment. We have no difficulty with the Leadite joints. The first joints laid with Leadite, back in 1901, are still intact and do not show any signs of deterioration.

MR. FRANK A. MCINNES.* For what it is worth I will give you one experiment that we made ourselves. Four lengths of 4-in. pipe and one short piece were jointed with Leadite, supported at three places, — at each end and in the middle. The center support was removed and a deflection of 22 in. followed without leakage, with no sign of failure of the joints. We then proceeded to load the center of the pipe. At a load of 100 lb. no leakage had developed, when the pipe suddenly broke in two in the middle, at a point 18 in. distant from the nearest joint, and where a 5/8 tap had been taken out of the 4-in. pipe and plugged with a cast-iron plug. At the time of the break there was a total deflection of 25 in. The span from support to support was about 48 ft.

That encouraged me to use Leadite in laying pipe on a bridge across the Neponset River. This bridge carries heavy traffic, including two lines of heavy cars. The necessary location for our pipes was within approximately 4 ft. of one of the rails, and about 3 ft. lower, on a part of the bridge where it was subject to serious vibration. We used Leadite. That experiment is still in process. It has been there for five months now. When the line was put in we had leakage — not serious leakage, but continual dripping. Before the pipe was covered up in order to protect it from frost, that leakage had nearly ceased, and subsequent examinations appear to show that it has altogether ceased. Owing to the snow conditions we have not been able to see it for the last month.

MR. JOHN DOYLE.† The city of Worcester has had some experience in this respect. Last summer we laid about 500 ft. of 12-in. pipe with Leadite, with very good success. We have not had a leak on it, as far as I know, since that time. We also use Leadite on the services. So far, I cannot say anything but praise for it.

MR. FRANK J. GIFFORD.‡ There is one very important thing in connection with the pipe-jointing material, and that is the ability to carry current for thawing purposes. I should like to know what the experience has been of Mr. Stevens, in thawing services — not the main pipe, but carrying current enough to thaw services.

MR. STEVENS. I will say that I have had a little experience in that line, and that Leadite is an excellent insulator. I have to state frankly that I can't get an effective thawing current through it. I have heard it suggested, that if you wish to overcome that you should introduce a little wedge of lead in every joint. I never tried any such thing.

MR. GEORGE MCKAY, JR.§ I think the Boston Water Department has made an experiment in thawing services, and they experimented

* Engineer Public Works Department, Water Division, Boston, Mass.
† General Foreman Water Department, Worcester, Mass.
‡ Superintendent Water Works, Dedham, Mass.
§ Of the Leadite Company.

with a lead wedge in the bottom of the joint, to see if they could get current through the service pipes, and discovered later on that they did not need to use the lead wedge. Leadite in itself is a very good non-conductor of electricity, as Mr. Stevens has said, and if you can insulate the spigot end from the hub to the shoulder you will have in time an insulated joint as nearly as possible. But quite frequently the spigot end comes up against the hub, and that would make a connection. But in getting current through the line you do not have to depend on that. For electrolysis you want to make your joint as nearly non-conductible as possible, and for that reason you will reduce your trouble with electrolysis. But usually your electrolysis difficulty is a very low voltage. In thawing out mains I understand the best results are obtained by keeping your voltage down to about 10 volts, and having your amperage at from about 225 to 300 amperes. We know that water in itself is a poor conductor of electricity, but yet you can get sufficient current through it to thaw out your services. That thin film of water will allow your current to pass through. I know that the Trenton Water Department during the winter of 1917–18, which I believe was the very severe winter, had 2 000 services frozen up, and I asked Mr. Bugbee if he ever thawed any lines on which the joints were made of Leadite, and he said, "Yes." I said, " Do you ever have any trouble in getting current through it? " He said, " No." They have had quite a good deal of Leadite in their system.

MR. STEVENS. That may be a question of amperage. We used a voltage of 110, an amperage of about 200.

MR. MCKAY. Your voltage was too high. You should keep it down to 25 and you would not have any trouble.

VICE-PRESIDENT BRUSH. What size pipe do you use the Leadite on, Mr. Van Gilder?

MR. VAN GILDER. All sizes, from 2 in. to 24 in.

MR. GIFFORD. I should like to know if any one has used that wedge, either of lead or other metal. Personally, the theory of the water conducting the electricity does not appeal to me. I have a lot of cement-lined pipe, and I know that the water won't carry very much electricity. We also have a shell of wrought iron that is butted up in the same way the previous speaker spoke of, which will not carry enough electricity to get much voltage or amperage. And if any one has used the metal wedge I should like very much to hear about it. I am interested in some substitute for lead, but I am very much interested in the thawing proposition. I think that is very essential.

MR. A. E. MARTIN.* We use the lead wedge in Springfield, but I can't tell you whether we get the current through it or not. We have not had occasion to use it. Before deciding to use the lead wedge we laid half a dozen lengths of pipe together in the yard, with the calking yarn in the joints, pulling the pipes just far enough so that they would not touch

* Superintendent Water Works, Springfield, Mass.

in the bells. We could not get any current, of course, through those pipes without some conductor at the joint, but when the wedge was put into the joint we could get the current through, and considered from that that it was easy enough to get the current through the pipe if you put the lead wedge in. So we are using the lead wedge. We bury our pipes in Springfield now, so that we hope not to get any frost in them, but have not had experience yet, so that we can tell. We have just got an electric thawing machine and had occasion to use it twice this winter, and could have used it two or three times more but the snowstorms buried us up so deep we couldn't get it out of the city.

MR. COGGESHALL. How deep do you lay your pipes now?

MR. MARTIN. Not less than 6 ft. deep, with 5½ ft. cover. That carries the service pipe down, with a little dip at the main, 6 ft. We bury all the service pipes 6 ft. deep. We have not had any experience yet that would indicate that it will not protect us from freezing. There were one or two instances two years ago where the frost went down 7 ft. deep, but those were exceptional.

A MEMBER. I should like to ask if there was water in that pipe when you tried to get the current through?

MR. MARTIN. No; it was dry.

VICE-PRESIDENT BRUSH. I should like to ask what size lead wedge you used.

MR. MARTIN. Just a small wedge, about 2 in. thick and 2 in. wide.

MR. MCINNES. I regret that I am not as familiar as I should like to be with just exactly what we did and what results we got. The same thing troubled me that has been bothering Mr. Gifford, but we have had no trouble at all in carrying current through the pipe laid with Leadite, nor have we had any trouble in carrying current from the main through the branch to the hydrant in at least three cases. We made the same experiment that Mr. Martin has told us about with a 4-in. line in the yard. Before we laid and put it in service we found out enough to know the conditions. But I personally did not make a study of that. I am pretty sure that we are satisfied with our use of Leadite.

VICE-PRESIDENT BRUSH. Mr. McInnes, what pressure did you have on that 40-in. line in the yard?

MR. MCINNES. Fifty-five lb.

MR. MCKAY. Speaking of pressure, I had an interesting thing happen in the office, a couple of weeks ago. A gentleman from Bluefield, W. Va., said that they had been using Leadite for about twelve years, and were going to use it under 140 to 200 lb. pressure in a line they were about to put in. That aroused my curiosity. I said, "What is the highest pressure you have where you are using Leadite?" He said: "350 lb. On one line of this 350 lb. pressure, which is a 10-in. line from the pump, the pipe was originally laid with lead, and it hung over the edge of a creek, where the earth was cut out from under the pipe. Every once in a while

it would work out, and we would have to shut down the pressure, jack it back in place, and brace it up again; but finally we thought we would try Leadite on it. We put it in with Leadite and it is still there, and under 350 lb. pressure at the pump."

MR. ROBERT S. WESTON.* We analyzed one of these preparations at one time, and we found it contained some, as I remember, 22 per cent. of iron filings, which ought to make it something of a conductor.

MR. GEORGE H. FINNERAN.† In Boston, after our experience with frozen pipes during the winter of 1917–18, we realized our dependence upon electricity as a means of thawing. As we had been using Leadite somewhat and had arrived at a point where we intended to extend its use, it occurred to us as desirable to know whether or not Leadite joints prevented the passage of electricity on our pipe lines. As a means of answering that question we assembled on blocking in our yard a section of 4-in. cast-iron pipe about 50 ft. long, containing about seven joints. Caps were placed on both ends and water admitted to the pipe under pressure. Corporation cocks were placed in the line at points between the joints. Connections were made with these cocks and a storage battery of eight 2-volt cells connected in series. Volt meter, ampere meter, and other necessary apparatus were used, but not the slightest indication of a flow of current through the joints could be observed. We then burned out the joints and re-made them, inserting in several a lead wedge about 2½ in. long, 2 in. wide, and ½ in. thick. The wedge was placed in the bottom of the joint and driven in so as to make contact between the bell and spigot, and the Leadite poured around it. Electrical connections were made, and we found that a flow of current passed through every joint which contained a lead wedge, but not through those without it. We allowed the section of pipe to remain under pressure for two weeks, and upon again testing the joints electrically, we found the conditions to be the same. As to the amount of current flowing on the pipe, it varied from 1 ampere to 400, and from 14 volts to 30. This amount of voltage and amperage was made possible by using 16 cells in our battery. No bad effects were observed in the joints during the flow of 400 amperes, other than the heating of the lead wedge to the point where it caused the surrounding Leadite to melt a very little. This could have been avoided by using a larger wedge. We next decided to make tests on pipes in the ground where we knew Leadite was used in the joints. We applied the current exactly as we would in an actual thawing job, with the following results:

At the intersection of M and Eighth streets, where a 12-in. gate had recently been established on the Eighth Street line, four Leadite joints were used. By connecting our positive terminal with the service pipe in the house located in M at Eighth Street, and our negative terminal with

* Of Weston & Sampson, Boston, Mass.
† Superintendent Water Service, Boston, Mass.

the pipe in the house located in Eighth at M Street, the current traversed by way of the pipes about 50 ft. of 5/8-in. lead pipe with brass fittings, 72 ft. of 6-in. cast-iron pipe with lead joints, and 36 ft. of 12-in. cast-iron pipe with four Leadite joints and three 12-in. lead joints. Under these conditions a flow was obtained which our meters indicated as 110 amperes, 16 volts. The soil in the vicinity is clay. We could have increased the flow by increasing the voltage, but we considered that which we obtained sufficient.

In Dudley Street, near Belden Street, we made connections with the supplies to two houses 100 ft. apart. The Dudley Street main is 12 in. diameter and jointed with lead except where a 12 by 6 hydrant branch had recently been inserted and Leadite used in the joints. This hydrant branch was located between the two services. By using 16 volts we obtained a flow of 87 amperes. Car tracks are laid in Dudley Street, and at this point one of the rails is about 3 ft. from the line of our main pipe. By transferring our negative terminal from the service pipe to the car rail the flow increased to 100 amperes. In my opinion, this indicated that the current, after traversing the service pipe to which the positive terminal was attached and the main pipe as far as the Leadite joints, jumped from the main pipe to the rail and followed the rail to the negative terminal, thus indicating less resistance in the soil between the main and the rail than in the main and the Leadite joints. Our experience in electrical thawing is that the soil very often acts as a good conductor, and where a hydrant or service pipe was not conveniently located for contact with our negative terminal, and a car rail was laid in the street, we always used the car rail as the negative electrode with usually satisfactory results.

In Assabet Street, Dorchester, where we laid 161 ft. of 8-in. main and established a post hydrant in 1910, using Leadite for joints, a flow of 215 amperes pushed by 16 volts was obtained between our two terminals. The positive terminal was connected with the sill cock of a house, and the negative terminal was in contact with a post hydrant. The distance between the two terminals by way of the pipes was about 160 ft., of which 123 ft. was 8-in. cast-iron pipe with Leadite joints, the remaining portion being 8-in. cast-iron pipe with lead joints, and 5/8-in. lead pipe with brass fittings. The ground was loam, quite moist, being at the bottom of a hill. Thinking that the soil might be a big factor in the flow, we cut out and removed from the ground a section of pipe containing a Leadite joint, and tested it for a flow from the bell to the spigot. We found a free flow, but upon further testing and closer inspection we discovered that the current traveled through a film or scale of what appeared to be rust which had accumulated on the face of the Leadite joint. When this scale was removed — and it required some vigorous cutting and scraping to remove it — the current ceased to flow. We then removed the Leadite from the joint and tested it for conductivity and found that the clean, uncombined Leadite would not carry current, but that combined with the scale

which adhered to its surface it became a conductor through the medium of the scale.

The conclusions arrived at through these and other experiments are that a Leadite joint by itself is a non-conductor of electricity; that cast-iron pipe lines with Leadite joints can be made to carry a current of electricity by the insertion in each joint of a metallic wedge, preferably of lead, of sufficient size and so placed between the bell and the spigot as to make good contact; that under certain conditions Leadite joints will not prevent the passage of a current of electricity along a cast-iron pipe line, as, for instance, where a rusty scale is developed on the face of the joints, making a path for the current from the spigot to the bell, or where the spigot butts against the bell and contact is made complete by the lodgment of rust between.

As a general statement based upon conditions as they exist in Boston, it is safe to say that in almost every case the soil will act as a conductor and offer a path for the current either around the Leadite joints or in some other way to the negative terminal; and that the use of Leadite as a joint-making material will not interfere with the use of electricity as a thawing agent.

DESCRIPTION OF MOTOR-DRIVEN PORTABLE THAWING MACHINE MOUNTED ON TRUCK.

BY FRANK J. GIFFORD, SUPERINTENDENT OF WATER WORKS, DEDHAM, MASS.

[*Read December 10, 1919.*]

Every water-works man who was in charge of a plant during the winter of 1917–18 is at this time probably anxiously watching the thermometer, and reading the latest predictions of some weather prophet with a local reputation.

Those of us, especially in the smaller plants, who had to personally supervise every detail of the thawing of frozen pipes as well as to hear the complaints of and pacify the irate householder because we had allowed his service pipe to freeze, have been trying to devise some economical and effective method of thawing.

It was the privilege of the writer to serve on your "Committee to Investigate Conditions in Water-Distribution Systems, Arising from the Severe Cold of Winter of 1917–18." This committee collected considerable data and information on the subject of thawing, methods, costs, etc., which was presented to the Association, September 11, 1918. Several types of thawing apparatus were described, some of which were in actual use, and others suggested as practical. Based upon the information obtained in the preparation of this report, the writer has formed the opinion that current as used for thawing purposes on small pipe lines has been at too high a voltage, involving more power for generation than necessary, as well as possible danger of damage to services and fittings.

The outfit which I am going to describe to-day was not mentioned in the report, but was developed from those suggested, combined with an old motor truck which our company had discarded early in 1917. In working out the present design, we have aimed to use reduced voltage and to discover some of the limitations in this direction.

The writer wishes it understood at the outset that he is not overburdened with electrical knowledge, but is fortunate in having a meter inspector who has a working knowledge of electricity and good mechanical ability. I wish to give Walter G. Hoffman, our meter inspector, full credit for the development of the ideas, as well as for all the labor necessary to perfect and complete the outfit.

The apparatus is mounted on a one-ton Koehler truck. This truck is a 1914 model, with two-cylinder motor rated at 24-horsepower. In our development of the unit, we discovered that the official power rating of an automobile engine is not the output that can properly be depended

upon for continuous-load service, and we have arrived at an output of about 15-horsepower as about right for endurance limits. (Fig. 1.)

The engine is suspended below the frame and partly under the driving seat, the fly-wheel being located about one foot to the rear of the seat.

It is due to this type of construction that we were able to develop the machine as it is to-day.

Having the truck, our problem then was to find a generator which we could run with the limited horsepower which was available and develop sufficient voltage and amperage. A second-hand C & C generator was

FIG. 1. TRUCK FOR THAWING OUTFIT.

located, — 2-pole, 125 volts, 16 kw. In its original form, this generator would develop more voltage and less amperage than desirable, particularly in making best use of the limited power available, and accordingly we had the windings rearranged for 55 volts.

In this connection, it was necessary to cut out the mica between every other segment and fill with copper. Doubling the width of the segments made it necessary to have brushes twice as thick as the old ones. Carbon brushes of sufficient thickness, made especially for this job, were tried. After testing we had to discard them, as we were unable to develop any current with this type of brush.

Copper brushes finally solved our problem. These were used by doubling up two commercial size brushes and making special brush-holders.

The generator is mounted on a frame made from 2 in. by 8 in. hard-pine planks and set with the pulley on the drive shaft directly over the fly-wheel of the engine. The fly-wheel and pulley are connected by means of an endless leather belt 5 in. wide. This belt hangs loose from the generator pulley when the engine is running idle or when truck is running between jobs.

The fly-wheel of this particular engine is 16 in. in diameter, and, having no means of determining how fast it was traveling, it was necessary for

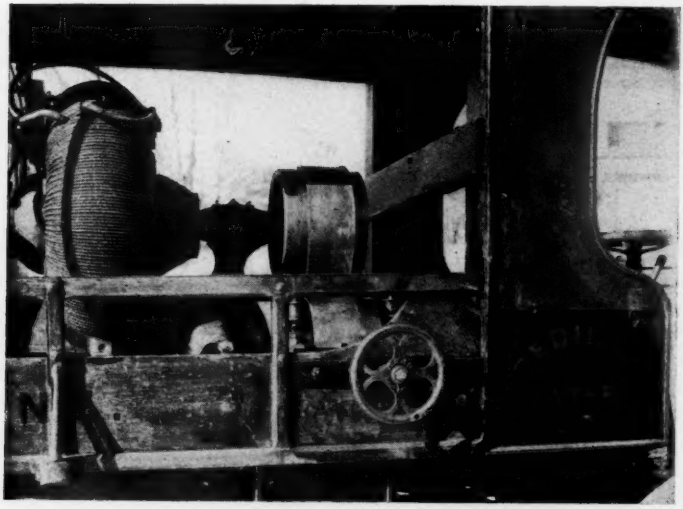

FIG. 2. HAND WHEEL FOR TIGHTENING BELT.

us to experiment, after getting connected up to determine the proper size pulley for the generator. A 12-in. pulley with 8-in. face was finally decided upon as being the proper size.

To transmit power to the generator when ready to begin thawing, the belt is tightened by means of an idler pulley mounted on wooden slides, connected by a screw operated by a hand wheel on the outside of the truck body. Attached to the shank of the screw just inside of the body is a ratchet-wheel on which a pawl is dropped to prevent screw from backing out, because of vibration, and loosening the belt when machine is working. (Fig. 2.)

Next to the generator, and mounted on the same wooden frame, are two wooden spools, acting independently of each other, each carrying 250 ft. of 4/0 copper wire. These spools are made with an axle shaft of 1¼ in. pipe. The inner end of the wire passes through the drum and into the shaft through a hole cut in the side, coming out at the end which projects

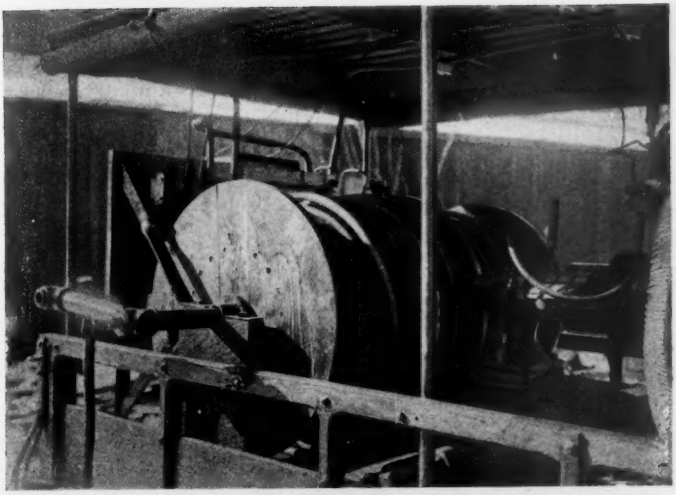

FIG. 3. SPOOLS OF 4 PER CENT. COPPER WIRE SHOWING WINDING CRANK.

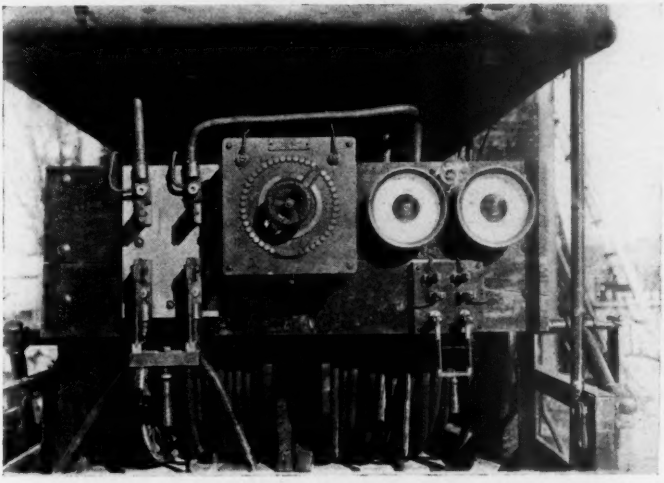

FIG. 4. SWITCHBOARD, RHEOSTAT, VOLTMETER AND AMMETER.

over the side of the truck. Here connection is made with the lead wire from the generator by means of a wing-nut.

A tee is made on the end of the axle shaft into which a handle is screwed so that the wire may be readily reeled up after use. (Fig. 3.)

At the rear of the truck, and on the frame which carries the generator and reels, is the instrument board. On this board is mounted the main

switch, a rheostat, an ammeter, a voltmeter, and a small switch which controls the lighting circuit. Five lamps have been installed on the truck for night work. (Fig. 4.)

Much experimental work was necessary before we were satisfied that we had an outfit that was practical. One of our first obstacles was to develop the maximum power of the engine and prevent excessive heat and boiling of the water in the radiator. At first we attached an auxiliary tank of water to the radiator. While this stopped the boiling to a great

FIG. 5. TESTING APPARATUS.

extent, the engine did not furnish all the power and speed we desired and which we thought it capable of developing.

The ignition was then investigated, and we found that our magneto was operating with a fixed spark, not far enough advanced to give us maximum speed. The magneto was removed, and six dry-cell batteries with a two-cylinder timer and spark control lever, substituted. This change gave us the desired speed, and also allowed us to remove the auxiliary water tank.

The final result obtained was to develop 230 amperes at 27 volts. This amount of current we figure will be sufficient for our work, although we are hoping that we will never have to use the outfit.

Our experiments were made with the full amount of wire carried on the truck in use and with water resistance. (Fig. 5.)

I regret very much that I am unable to give you the exact cost of the outfit as it stands, as all the labor was performed by Mr. Hoffman when he could spare an hour or two. No record of this time was kept.

Much of the material used in the construction was discarded material such as can be found around any water-works plant.

The largest item of expense was the generator. This, together with the switches, rheostat, ammeter, and voltmeter, cost $150. The expense of rewinding the armature was $90. Other material which we had to buy, including wire, amounted to approximately $235.

DISCUSSION.

MR. J. M. DIVEN.* What we are looking for is some self-contained apparatus at a moderate cost. That cost, I should say, should be within a thousand dollars, to be available to the smaller water works; that is, the gasoline engine, and so forth, which could be mounted on skids that could be run out in wagons or sleighs, for instance. Sometimes in the northern part of the state of New York they have frozen services when there is three or four feet of snow on the ground. It would be rather difficult to operate a truck under those circumstances. Of course he did not estimate the truck, and in buying a new truck we would find the cost prohibitive, because probably a one-ton truck would cost fifteen hundred to two thousand dollars, anyhow, if purchased now.

MR. GIFFORD. We had thrown that truck away, and it was discovered and resurrected.

MR. DIVEN. We are still in hopes that somebody will devise and manufacture an apparatus costing within a thousand dollars that will be self-contained, and that can be stored away, mounted on any truck.

Formerly, the shut-offs to services were located at the mains, and during the year 1917–18 we wished they had been there.

Another great difficulty any thawing apparatus would not reach is what they call "sub-laterals," put in before the street is paved. There were some fifty-odd of those in the city of Troy that were frozen, burst, and had to be taken out during that cold winter.

MR. REEVES J. NEWSOM.† I should like to ask Mr. Gifford if he has any data as to the probable amount of current required in thawing the ordinary services. Whether that has been determined as the result of any test you have made on this.

MR. GIFFORD. All I have to say on that is that the committee report in 1918 contained that.

MR. NEWSOM. I have developed a self-contained outfit along these same lines. I can't give much information as to the cost, or much hope that it will cost a very small amount; but I succeeded in locating a 6 by 6

* Superintendent, Water Works, Troy, N. Y.
† Commissioner of Water Supply, Lynn, Mass.

marine type engine, which is capable of delivering in excess of 25 h.p. In connection with the generator designer at the General Electric Company in Lynn, after talking over many schemes for making up such an outfit as this, we finally decided that the generator which was used recently for furnishing power to these large searchlights would be about the proper thing to hook up to an engine of that sort. I discovered, as the author of this paper did, that the voltages that had been used were too high, and we rewired this generator so that it would give about 55 volts, and we also found that in order to put out large amounts of amperes copper brushes would be required. We have mounted the entire apparatus on two steel I-beams, and the generator is directly connected to this engine and can give us in the neighborhood of 500 amperes, 50 volts. We are just now ready to start making some experiments as to what is required for different sizes of services, and whether or not small mains can be thawed with an amperage of that amount with a voltage of 50. We have hopes that it may be fit for not only all kinds of services but small mains and dead ends that give us trouble.

MR. GIFFORD. I think the committee found that thawing ordinary ¾-in. services required 175 amperes, taking about six minutes.

MR. NEWSOM. At what voltage?

MR. GIFFORD. About 30 or 32 volts, I think.

MR. FRANK L. FULLER.* I should like to ask Mr. Gifford if this truck is in ordinary use or whether it is kept with this apparatus permanently attached?

MR. GIFFORD. The apparatus is attached on 2 by 8 skids. We can slide it out. We have no use for the truck.

MR. MORRISON MERRILL.† I should like to ask Mr. Gifford if he has had any experience with alternating current in thawing.

MR. GIFFORD. Only as used from the electric-lighting system.

MR. MERRILL. Did you notice any particular features regarding the alternating current?

MR. GIFFORD. I do not know as I understand just what you mean by the "features."

MR. MERRILL. What I mean is that I never have used direct current in thawing, but I have used the alternating current a great deal; in fact, I had charge of the thawing out in Wakefield. And I noticed there was quite a vibration, either on large or small service pipes, from two inches down, caused, I presumed, by the alternating current. I was wondering whether it had anything to do with improving the thawing properties of the current. If you put your hand on the pipe you can feel the vibration, which you won't get with the direct current.

MR. GIFFORD. I do not know as I can answer that question, Mr. Chairman. I think an electrician will have to answer that.

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* Civil Engineer, Boston, Mass.

† Superintendent Water and Sewer Department, Wakefield, Mass.

PRESIDENT KILLAM. Mr. William N. Bonner is here, of the Public Works Department of Boston. He is an electrician and perhaps can answer.

MR. MERRILL. My point was that, after you connect up with the waste in the cellar and also the main in the service box and the current is applied, you can feel the pulsation, or the alternations, if you have a mind to call them so, of the current in the pipe. I was wondering if that had any real value in thawing other than the heat that is produced by the current passing through the pipe.

MR. WM. N. BONNER. In answer to the gentleman I would state from my experience with both currents that it is hard to determine whether you have the required amount of current, regardless of the sense of touch, by pulsating movement. My experience with direct current is that it is impossible to determine just when the water will come. It does not create any heat in order to enable you to determine. There are times when some men make mistakes by raising their voltage, which naturally decreases the amperage in proportion to the voltage, so as to create enough heat to enable them to determine that the pipe is getting warm. As I said before, you are making a big mistake by doing that.

MR. J. A. HOY.* In regard to approximately what it costs to thaw by electricity, I would say that in Worcester we have done approximately 409 services with current furnished by the electric light company of Worcester, at an approximate cost of $3.76 per service. It is a question whether, if you had your own equipment, with the number of amperes that you have to use, you could do it at that cost. We have done approximately 4 200 with just the hot water, where we had a straight run. Of course if there were angles and turns you would require thawing apparatus. But the electric light company furnished about five or six men, and the approximate cost was about $3.76 a service. Now, if you had your own equipment you would require a number of men, and, taking the labor into consideration at the present time, it would probably cost considerably more than that. Of course on the electrical part of it, it takes time to wire it and get all ready, while you would be ready and going ahead with the thawing by the hot-water process, you would have so much more of a start, and if you had a straight line you would perhaps have it done so much quicker than with the electric light company thawing it out.

MR. DIVEN. I do not think I could get it done as cheaply as that; I should want the apparatus. There might, however, be frozen services where the city current was not available. We paid during that cold winter $10 per service to the electric light company, plus the cost of the current.

MR. DAVID A. HEFFERNAN.† We had a private concern do our thawing in Milton, and it cost us just $50 a day. They had three men, including

* Foreman, Water Department, Worcester, Mass.
† Superintendent, Water Works, Milton, Mass.

the chief engineer, and we had to hire one man from the Edison Light Company. And they had one man for inside work. We ran up against bad weather, for instance, and if we had a rainy day, or something like that, the men would not work. The apparatus was put on wheels, horse driven. We were up against it in stormy weather. Now, $50 a day is pretty expensive. Of course the Dedham Water Company was very fortunate in having a second-hand truck, and I think if you can get an outfit like that, get a second-hand truck, a second-hand generator, and the other fixtures that go with it, at an expenditure of $1 000, or something like that, that it is money well spent, and then put the apparatus away, store it for the bad weather. From the present reports of the storms and cold weather they are having in the West, I think Mr. Gifford may have use for his apparatus before long. Suppose we did get cold weather at this time. You don't know whether you will be able to get this machine or not. There are not very many of these machines on the market, and you have to wait your time. We worked during that cold spell, night and day, from December 29, I guess for three weeks, before we got rid of the machine. It cost us over $700. We got nothing in return, nothing to use in the future. Now, if you can get an equipment ready for $1 000 or $1 200, and lay it aside for a case of emergency like that, I think the money is mighty well spent. I congratulate Dedham in being ready for any kind of weather that comes along.

MR. GEORGE MCKAY, JR.* I had occasion to look into the matter of thawing out services some time ago, and I ran across a plant they have at Trenton, N. J. They had about 2 000 services frozen in 1917 and 1918, in the freeze-up at that time, and they built a self-contained plant, — it was a generator with a new motor, — fixed it up and put it on a truck, and thawed out their mains with about 225 to 250 amperes and about 10 volts. If anybody is interested in getting further details they can write to Mr. Bugbee, and I am sure he will tell them the plant has worked very efficiently.

MR. GIFFORD. I should like to have Mr. McKay tell us what experience he has come across in thawing mains where the joints have been run with Leadite or some similar preparation. I understand he has had some experience.

MR. MCKAY. Mr. Bugbee said they had about 2 000 services frozen and I asked him if they had ever thawed out any where the lines were laid with Leadite and he said, yes, and that he never had the least trouble in thawing out the services. Leadite, of course, is a poor conductor of electricity, but you do not depend entirely upon that, and unless you have an insulated gasket you will have a film of water there. Even a film of ice or water will carry sufficient current to thaw out your services. When they have had any trouble in thawing out services it could probably be traced to some other cause. Water itself will carry sufficient current,

* Of the Leadite Company, Philadelphia, Pa.

and the trouble had been they used too high a voltage. If you keep your voltage down to 250 amperes you will thaw out any freeze-up you run across; at least, that was their experience down there with 2 000 services. Boston has also made experiments. I was getting this information at the time, and they discovered it themselves, — that they could thaw out services with leadite joints. They discovered it just about the time I got the information, but I sent it along anyway. I think Mr. Hawley, too, of the Pennsylvania Water Company, has also — I am not sure about this, but I think he is thawing out lines with Leadite joints. He had quite a few miles of it laid.

Mr. Gifford. The testimony which the committee got last year was that mains run with Leadite or similar preparations were impossible to thaw. I understand the City of Boston has been making experiments, using material of that kind for joints, putting a lead wedge in the bottom to carry the current. Perhaps Mr. Bonner could tell us something about the experiments they made in that line.

Mr. McKay. I believe when they started to make their tests they did put a lead wedge in the bottom of the pipe to thaw it out, but they afterwards discovered it was not necessary.

Mr. Bonner. In answer to Mr. Gifford, would say that that is true, that we did decide to make the test by inserting the lead wedge. Of course naturally it was satisfactory, but that lead wedge had to be the equivalent, or, in other words, to be of the same diametrical measurement as the wire. In other words, if you used a 14-gage wire, there is a maximum limit to the carrying capacity of that wire. If you go above the carrying capacity of the wire you melt it. That applies to the lead wedge. For example, if you put a lead wedge in about $\frac{3}{8}$ in. square and then send 350 amperes through it, your wedge is gone. In order to overcome that you would naturally have to build your lead wedge in proportion to the maximum current required for the thawing. There is no limit to that.

However, to make a long story short, it has been decided — and it was very cleverly designed by Mr. McInnes and Mr. Finneran who were determined to make a careful analysis of this so-called Leadite — and after two or three different tests, I have come to the conclusion, and I have been at the electrical business going on fourteen years — that Leadite does not retard the progress of electricity in any way, shape, or manner, as long as it is properly run.

Mr. H. V. Macksey.* I merely wish to say, Mr. Chairman. that I appreciate the value of the work done by Mr. Gifford. Of course he is a pioneer, and like all pioneers he has to work with the material that he has. But there is one great difficulty which a man working in a small city or town meets that he gets rid of. Now, if you are in a large city and you have services frozen by the thousand, it is safe to say that you have blocks and they are frozen right along, and your crew can slip from one house to the

* Superintendent, Public Works, Woburn, Mass.

next, and you do your work very cheaply and very rapidly. One connection with the overhead wires of the service corporation will do a lot of work for you. But if you are out in a sparsely settled district and are fortunate enough not to be frozen up generally but get a bad one here and there, in that case you have long jumps between and a new connection to be made every time, and those things cost money. Not only that, but under certain weather conditions it may be that you will not be able to connect up to the overhead wires, and then you are tied up at a time you ought to be working, and might be working if you had such an apparatus as is contemplated and carried out by Mr. Gifford. So that if we can find some apparatus of our own, which can be moved around well in all kinds of weather and put to work, we will accomplish something, and will have something which the service corporations cannot give us.

Then there is another thing to say. You spoke of being saved the expense of the expert men from the electrical companies. There are very few men who are particularly expert in this kind of a problem. They are just butting into it and feeling their way, the same as we all have to do. And it seems to me that it would be well for the companies, and the cities and towns operating water supplies, to try and build up their own little experts in that particular line, as they have in others; for we have found by experience that it pays better to keep our own men right on the job to do our work than to depend upon contractors on almost any class of work that we do.

EXPERIENCE IN METERING FIRE SERVICES.

FREDERIC E. BECK.*

[*October, 1919.*]

After experimenting for several years in an endeavor to find some method whereby the flow of water through strictly fire-service lines could be controlled and the amount of water used or wasted through such lines obtained, it was decided early in the present year that the only positive method of obtaining this information was to install meters on all fire-service lines connected with our mains.

In making this decision to install meters on all fire-service connections, of which we have 230, we were governed by the fact that we had positive knowledge that large amounts of water were being either used or wasted through these lines. This information was obtained from time to time by means of the Pitometer survey which we were making, in order to reduce our underground leakage, together with the visible evidence of seeing roofs wet down during the hot summer days, several fire streams being played simultaneously on huge coal piles for days at a time, and such other like usage of water which *might* be taken from our mains without our knowledge and without payment for the water used.

On investigating cases of this kind, we usually found that the water being used was supplied by pumps on the secondary source of supply, which in our city is a near-by canal, and was not taken from our mains. In several cases, however, the flow was entirely from our mains, and taken through fire-service connections.

In order to lighten the financial burden of metering 230 services, it was decided to first meter those plants having outside yard systems, where the chance of underground leakage was greatest, and to proceed with the metering of the balance of the services at a rate that would insure the complete metering of all services within a period of four years.

During the past season fifty fire-service meters have been installed, and the results obtained certainly warrant us in the completion of our program.

All meters are located as near the street line as possible, and are placed in brick or concrete pits; and all expense and cost of setting, including cost of meter, is borne by the company, a nominal service charge being made for each service, in addition to requiring payment for all water passing through the meters, excepting that used for the extinguishment of fires or the testing of the equipment. In case of fire or testing of equipment, the consumer is required to give notice on cards furnished for the purpose, which show the time and duration of the fire. The allowance

* Chief Engineer, Consolidated Water Company of Utica, N. Y.

for water used for these two purposes is then based on the normal flow of water through the meters, as shown by previous meter readings.

The annual service charge for fire-service connections is $40 for 4-in., $50 for 6-in., and $75 for 8-in. connections. In defense of this low service charge it is necessary to state that all fire-service connections are made at the expense of the consumer from the main to the property line. I am not, however, defending this method of installing services at the expense of the consumer, but simply our low service charge.

The cost of installing the meters on service lines already in use has averaged $153 for 8-in. meters and $135 for 6-in. meters, with a range of from $80 to $239 on the 8-in. size and from $75 to $182 on the 6-in. meters; these prices do not, however, include pavement replacement, but include all other labor and material costs for placing meter and constructing meter pit.

On the fifty meters installed, all but three show a constant flow of water, the three exceptions being new connections to buildings having no yard system and but small sprinkler systems.

The rate of flow through the fire-service connections varies from 6 to 3 000 cu. ft. per day.

But little opposition has been encountered from the owners or managers of the plants metered, and where the flow of water could not be traced to unknown connections with the fire-service pipes, they have been extremely anxious to locate and repair any leaks which might cause a loss of water.

In view of the results obtained on the fifty services metered, I would advocate the placing of properly designed meters on all fire-service connections, and especially those having extensive systems of piping with yard hydrants attached.

Discussion.

Mr. Frank L. Fuller.* Please tell us what kind of meters were used.

Mr. Beck. We use, in Utica, the Neptune Protectus; not that that is the only meter for that service, but we are standardized on that meter.

Mr. J. M. Diven.† Have you had any trouble with the Underwriters' Association in the installation of meters?

Mr. Beck. Not the underwriters. The Mutual Insurance companies have made us several visits on that subject. They do not approve the metering of fire-service lines. It is because it is one more attachment on the main that they would rather not have there.

Mr. Diven. We put meters on fire services without consulting the underwriters, and had a very sharp letter from the Underwriters' Association at Syracuse saying we were installing these meters contrary to their

* Civil Engineer, Boston, Mass.
† Superintendent, Water Works, Troy, N. Y.

rules and regulations. My reply was that we were making the rules and regulations for supplying water, and were running the works under our regulations and not under theirs. They said there was no stealing of water.

At the first mill examined, we found a 1½-in. connection. This mill claimed they were using only a fire service, for which they paid a nominal sum of $20 a year, for a 6-in. connection. We found this 1½-in. connection running to an old-fashioned water closet, under full head, and traced it to the fire service. Finally we shut the fire service off to convince them that that was where the water came from. "Well," they said, "there might be one case."

The next factory was almost directly across the street. Before going in we shut the water off to see if they said anything. We had hardly got through the door before the engineer came in great distress, saying we had shut the water off, while he was filling his boiler. We told him we were not shutting the water off from his boilers, but shutting off the fire line to test it.

After a little while we got on the street car to go to the next mill, but they did not leave the car; they had seen enough.

You spoke of using the by-pass in closing down the line. I have had another run-in with the insurance authorities on that, they claiming I had no right to shut that down, as a fire might occur during the test.

MR. BECK. That is why I do not consider the test satisfactory. You can't shut it down for twenty-four hours, which is the desirable length of test.

Another thing I did not mention was the charge for water. We make no charge for water used for fire prevention or testing. We are sending a card out to the factories with the request that they fill it in in case of use of water for fire prevention or testing, and return it to us.

MR. GEORGE H. ABBOTT.* Do they usually send the card back to you?

MR. BECK. It is a part of our system which is not yet in working order. We are just getting those cards out.

MR. ABBOTT. It has been our experience that they pay no attention to those things at all, and then the manufacturer wants a reduction in his bill for water used for testing.

MR. BECK. We undoubtedly will get that later, but we have not been up against it yet.

We have had a conference with one representative of the insurance company, and with a mill owner, relative to illegal taking of water from the fire-service pipes. The mill owner claimed that if we found a mill taking water it should be metered and made to pay for it, but the honest should not be made to suffer for the acts of the dishonest. We had just installed meters the day before on his plant. At five o'clock I sent a

* Treasurer, Water Company, Southbridge, Mass.

man out to read the four meters, and there was a registration through the four meters which amounted to $96 a quarter at our rates. We met in the evening and he repeated that if water was being taken by any mill it should be metered and the owners made to pay for it. After getting that fact firmly established I showed him the readings of their four meters, indicating that they were not among the innocent, and the meeting adjourned.

MR. ABBOTT. You would have to install a meter to find out whether they were honest or not.

MR. BECK. Yes.

MR. ABBOTT. Do you pay for the meters?

MR. BECK. Yes. And before this meter service we had a charge for fire protection of 37 cents a thousand valuation of building and contents. But then there was a rule made that gave a discount of 20 per cent. for each hundred dollars' worth of water used for domestic purposes. As all of the large mills use over five hundred dollars' worth a year, they had their protection free. They objected somewhat to this additional charge of $50 to $75, but not seriously. After metering one plant, talking with owners of another, and showing the record of the first metering, there was no arguing on their side.

MR. ROBERT E. HORTON.* It seems to me that the subject of metering fire services is one of tremendous importance. Something was said this morning about the ratio of night and day consumption. Every one of you that has had anything to do with the matter of water-waste prevention has probably run across instances of unexplainably large night consumption. I believe one ratio was given which was about 80 per cent. I ran across a ratio of 20 per cent. in night consumption between two and three o'clock in the morning as compared with the average of twenty-four hours. I was called into a small town to find out why it was they were short of water and very quickly found that they were not uniformly short but only some of the time, and they left me free to do what I wanted to. We said in a vague way we were going to make night tests. We found that there were two prominent factories in that small town, and one of them used water very extensively at night. The other used it twenty-four hours a day. One of those factories had a well and some one said, " If you go down to Jones's mill and see that well, you will realize that the thing for you to do is to build a well somewhere in that location and get all the water you want; they have an inexhaustible well there that yields 100 000 gal. a day, because they use that much in the mill." I went to see the well. They had a fire-service main, a 4- or 6-in. line running into the mill. They were not taking any village water; according to report, had no connection with the main for taking water. But, for some reason they were unable to explain, they had a block of concrete some 8 ft. wide, and probably about 3 ft. thick, extending from the curb

* Hydraulic Engineer, Albany, N. Y.

in front back into the mill. The pump used to pump the water from this well was located at the rear end of that block of concrete. The reason for extending it out to the curb was not given. I was very much pleased with the situation as I saw it. They were undoubtedly pumping 100 000 gal. or more of water a day.

Another rather surprising thing about it was that the pump was not consuming any power. You could connect it up, but there was no back lash. Apparently, if the shafting had been disconnected, the pump would have run just the same. I could not explain that, and thought also that the water was of a very remarkable character. I wanted it analyzed and was very enthusiastic for the city to get another well like that if they could. They allowed me to take a sample or two. Now, the village water supply was taken from a village several miles away, and was very soft water; the water from the place where this mill was located was invariably of a different character. Strangely enough, this well analyzed almost identically with the analysis of the village water.

Now, if the fire-service meter had been put in on that line when the fire-service line was first put in, the village would not have been short of water, and one engineer's fees less would have been the result.

MR. DOW R. GWINN.* Several years ago we had a rate case before the Public Service Commission of Indiana, and, in the order, it was required that all private fire lines should be metered, with a minimum rate for fire-line services, 50 per cent. greater than the minimum rate where fire service was not used. We then started in to set the meters on the fire lines. In one case where they were supposed to pump their own water to the factory the inspector reported that he found the hose connected with the fire hydrant running into the factory. I asked him if there was any water going through. He said he couldn't tell, only it was inflated as large as it could be. We then put the meter on. This concern had a 6-in. line to supply 3 fire hydrants for fire protection only. They were paying us $10 a month for fire service, and seemed to take it for granted that they were donating that much money to the water company. Their bill last month was $255; the month before I think it was $247; the month before that it was $184, but they do not say a word. They pay these large amounts with less comment than they used to pay $10 a month.

By the way, I should say that on these 6-in. lines we have set 4-in. meters. We do not see any sense in puttin a 6-in. meter on, because they do not need it. If they had a stream from each fire hydrant, getting 250 gal. a minute from each one, they would not exceed the capacity of the 4-in. fire protection meter. The minimum rate on a meter of that size is $22.50 a month. They are allowed $22.50 worth of water for that amount. So that fire protection need not cost them anything. The company furnishes the service pipe up to the curb and sets the meter; furnishes it all free of charge. We have one 8-in. fire-protection meter,

* Manager, Water Company, Terre Haute, Ind.

and the minimum monthly rate on that is $150. They do not object to it at all. They are supposed to pump their own water, and they do pump some water, but this concern had a bill in December of about $650.

MR. DIVEN. They must be using city water for power to pump with.

MR. PAUL LANHAM.* I have had experience in testing a large number of meters with Pitot tubes. A large number of those have been fire-service meters. In practically all cases, I might say, the fire-service meters are not meters at all. That is, as long as the stream of water going through the fire service is small, the meter is accurate; but as soon as the stream becomes large enough to open the check-valve, in the commonly used type of fire meter, the meter is *nil*. In a great many cases the slippage is 100 per cent.

I should like to ask Mr. Beck if he has any reason to believe that the Trident meter is free from that defect.

MR. BECK. The only test we have made on a 2-in. connection was on a meter by-pass. It registered 98 per cent. on a 2-in. stream.

MR. LANHAM. Well, I can say that on new meters I have tested and seen tested the accuracy has been all right on the type of meters I was referring to. But the trouble is that the meter which is called upon to measure the fire-service flow remains idle most of the time, may for years, and then, due to increased underground leakage or the beginning of illegitimate use through the fire line, that meter is called upon to operate and fails. If you are dependent on meters of that sort you are practically without meters on the fire line after a few years.

MR. DIVEN. Do those tests include both the detector meters and compound meters?

MR. LANHAM. I would be inclined to say that my experience has been wholly with the detector meter.

I do not know where to draw the line between compound and detector meters. The Hersey Company, for instance, has two types of meters. It has a purely detector meter, which makes no effort to measure the flow, and then there is the type F.M.

MR. DIVEN. I refer to the two general types, — detector and compound.

MR. LANHAM. Well, it covers both of those.

MR. BECK. Unless we have a great change we will not be up against the large meter, not being called upon to operate, because they are all operated several times a year.

MR. LANHAM. Is that on account of fire tests, or something of that sort?

MR. BECK. Use of the main. Leakage, I do not think, would amount to much. Practically every meter is consuming water, even the fire-service meter.

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* Engineer in charge Waste Prevention, Washington, D. C.

MR. LINCOLN VAN GILDER.* I think one of the most important features of the fire-service meter is the fact that even though the fire service were not registered it would not be a very serious loss, for the reason it is used a very few times in the lifetime of the meter. Most cities would not think it a very serious matter, for they do not get any revenue from pipe used exclusively for fire.

MR. CHARLES W. SHERMAN.† I am informed a great many cities and towns make no charge for water used for fire service. And the water that is used for fire purposes would be deducted even if measured in making charge for the service. I think that is an entirely appropriate and proper practice. So that there would be no such condition, even though the fire-service meter failed to register all the fire flows, if the small meter registered all the other flows. I judge that did not prove to be the case with Mr. Beck.

MR. W. C. HAWLEY.‡ What Mr. Sherman says is undoubtedly true in a great majority of the cases. But we get what is equivalent to a fire flow when there is no fire. We are getting it time and time again. I cannot give any explanation or any reason why. Unfortunately, the additional meter does not seem to gage that flow. We know that the check-valve is open because the telltale meter indicates it.

There was another case where, for years, we tried shutting the valves and testing with a by-pass meter. There was always more or less leakage, and we were unable to get any reasonable response from the management in the way of making repairs. We began testing regularly and rendering bills on the basis of the average of the tests, and when they found they had bills to pay they got busy and most of the leakage stopped, but still there was water going through. In the case of some of our tests we discovered they were taking large quantities, and then I put the detector meter on and found they were taking for various purposes which they considered perfectly legitimate. They are now paying for that. In that case the rates of flow were not sufficient to open the check-valve.

Mr. Horton's experience reminds me of an incident which occurred about ten years ago. We were furnishing water to an amusement park. They had two lines; the fire line was not metered and supplied several fire hydrants only. I was a little suspicious and had the place watched for some time. There was a hose attached to one of the hydrants, and sometimes there were indications of water at the end of that hose. I went up to the park one evening, with my wife and little boy. The boy discovered the miniature railroad and we had to take ride on the cars. While we were sitting on the cars a policeman stepped up to the engineer of the locomotive and said: "Well, you certainly filled her up last night," referring to the pond for the "shoot the chutes." "Have you got orders?" "Yes, to fill her up whenever I please." I went home and got my men

* Superintendent Water Works, Atlantic City, N. J.
† Of Metcalf & Eddy, Boston, Mass.
‡ Chief Engineer and General Superintendent, Pennsylvania Water Company.

and we stayed there that night and watched them take water from the fire hydrant. We shut the water off the next morning, and before we got through got something over $500 in settlement. It was rather an unusual way to get the information.

MR. BECK. I think, in the connection you speak of, with a large and a constant flow, I would not treat that as a fire-service line. I would treat it just the same as any other line, and meter accordingly.

MR. HARRY A. BURNHAM.* The metering of fire-service connections has been a perplexing question for several years. It is a generally accepted fact that for the scientific operation of a water-distributing system, metering is proper and usually necessary for all connections through which water passes for domestic or industrial purposes. Connections in this class are mostly small in size and large in number.

In the case of fire-service connections which are large in size and comparatively few in number, the need of metering is not so apparent because, with the standard fire-protection equipment of sprinklers and hydrants supplied through a connection independent of the industrial pipe system, no flow is expected excepting in case of fire. With a well-maintained fire system and normal conditions, no flow need occur from year to year excepting for prearranged inspector's tests and normal leakage.

Much ingenuity has been shown in recent years in the design of meters to obtain the unobstructed waterway necessary for large fire flows, and there are doubtless places where these meters are necessary.

The matter of conservation of water supplies is always with us, and is of the utmost importance. The Mutual Insurance companies desire to assist the water-works engineers in every possible way to properly control the use of water from fire systems in the manner best suited to conditions as found.

I might add, in connection with the story Mr. Hawley just told, a little experience I ran across in a large city, not long ago, where the water company continued to present very large water bills rendered from a detector meter, and the concern paid them under protest for two or three months, and finally, after they had exhausted all other resources of finding where the water was going, they took the meter apart and found a block of wood caught in such a way as to deflect a large part of the flow that should have gone to the straight line through the meter. The outcome of the whole thing was that the company that had that meter on its premises got a lot of money back.

MR. DIVEN. Can you tell us the size of that block of wood?

MR. BURNHAM. It must have been 3 by 4 in., or perhaps 5 by 6 in. in size, such as commonly comes in pipes.

PRESIDENT KILLAM. I might say that in 1907 a general act was passed by the legislature of Massachusetts for the Metropolitan Water District, which included everything but fire lines. In a section of the

* Engineer for Factory Mutual Fire Insurance Company.

city were two fire lines for high service. They had given us considerable trouble, and for years we had not been able to know just what was taking place. The city authorities claimed that it was all used for fire purposes; that they had inspected the premises and could not find anything else. I was not entirely satisfied, and recommended putting in cocks each side of the main valve, for testing at least twice a year. Several tests showed what you might expect on a line of that length with leakage. Of course, when we made these tests we had to notify the city authorities, so that in case of fire they would be protected and we could open the valve readily. We had a man stationed there all the time. At last I decided to notify just the fire department, and run a test ourselves. We got a very large flow on one of the mains. I called the attention of the city authorities to it and they investigated it and said they could not find anything. That went on for about a year, and finally I recommended putting on a detector meter of some kind. The city authorities were requested to install this detector meter. They did not refuse but they did not comply. That went on for about six months, and then our commissioners notified them that if it was not installed in sixty days the line would be closed permanently. They made preparation at once to install that meter. The meter was installed in May, and the average since that time has been 30 000 gal. a day from that metered service. It is being used by some of the factories along the line that are supposed to have only fire services in their buildings.

MR. BURNHAM. I was hoping, during this discussion, something might be said about first-hand experience in sealing hydrants and sealing sprinkler drains, and such things as that, which I am quite sure the water-works superintendents have had something to do with, in order to properly control the taking of water from the water systems.

MR. H. T. GIDLEY.* In our town a 6-in. main furnished fire service to a large factory, and there was no evidence of their having taken any water from this fire line, except for their boilers which metered all right. Still, when we installed the detector meter we found they were using water from the fire line at the rate of 45 000 cu. ft. a month. They must have taken it from the service way inside, where we could not detect it until the meter was put on.

MR. WILLIAM F. SULLIVAN.† The only case I know about of the sealing of fire services, except in the larger factories, is rather unsatisfactory. The smaller factories, where there is not that close supervision, the minor officials, the master mechanic or some one else, have a habit of breaking the seal and requiring the water department to re-seal and go to the expense of an inspection. Of course, I speak now of a place where there is no charge for fire service.

MR. A. E. MARTIN.‡ In Springfield we have adopted the plan of metering all fire services, — all new ones, especially, — and our old ones

* Superintendent Water Works, Fairhaven, Mass.
† Superintendent Pennechurch Water Company, Nashua, N. H.
‡ Superintendent Water Works, Springfield, Mass.

as fast as they can be worked up. If I understand Mr. Beck right, they are installing the detector meters free of expense to the consumer. Is that so?

MR. BECK. That is right.

MR. MARTIN. I think there is a decision by the Massachusetts Supreme Court that it is not only right and proper that those services should be metered but that it is right and proper that the owner should pay for the meter as well as the installation of it. We have adopted the policy and are requiring the owners to pay for the meters.

I am going to say that in requiring payment for water, we attempt to divide the water used for extinguishing a fire, — we do not charge for that amount of water, but for all other water, for whatever purpose used, we collect. I think that Mr. Abbott (from Southbridge) says that they do not charge in that town for the water used for inspection purposes. We distinguish between those, and just simply say, for all water used for extinguishing a fire.

MR. SULLIVAN. I would say that our rule is similar to Mr. Martin's. That was a Supreme Court case in Lowell, wasn't it?

MR. MARTIN. Yes.

MR. SULLIVAN. We do not charge for extinguishing the fire, but on all new fire services charge for the meter, but nothing for inspection.

MR. VAN GILDER. We charge, in Atlantic City, the cost of installing the service from the main to the curb, but furnish, set, and maintain the meter free of charge. We charge for all the water the meter registers unless it can be shown that the water was used for fire prevention. If that is the case we make a proper rebate. There has been no difficulty in arriving at that.

MR. GEORGE H. ABBOTT. I would say that in our town we tell the owner to put on a fire-service meter and charge him for the water that is used, but not for what is used for fire. When the meters were first installed we gave the owner the first quarter to stop leaks at his factory and do as much as possible to eliminate the waste before sending the first bill.

MR. EDWARD D. ELDREDGE.* I should like to ask the speaker, in reference to the meters he spoke of, — where he locates them, whether on the land or in the street.

MR. BECK. We endeavor to locate every meter at the curb line if possible, but in some cases we can't do that, and in one or two cases we have put them in the basement of the mill or building.

MR. ELDREDGE. Is there any trouble with freezing?

MR. BECK. We have had no trouble yet. We only started this spring installing them, but have had other meters and had no trouble with them.

MR. C. W. SHERMAN. Are they located under the sidewalk?

* Superintendent Water Works, Onset, Mass.

MR. BECK. Partly under the sidewalk, and between the curb and the sidewalk, in the park spaces.

MR. SHERMAN. Mostly between the curb and the sidewalk?

MR. BECK. Yes.

MR. MARTIN. In regard to freezing. It is a very simple matter to protect one of those large meters from freezing by putting in a false cover on the inside. We build a little ledge around in the brick above the meter, just high enough so that the dial of the meter will come up through that, and that is permanent and stays there unless we have some repairs to make. Put in a double floor, as you might call it, just above the meter. That makes an air space around the meter. We have never had a detector meter freeze.

MR. KILLAM. How long do those boards last?

MR. MARTIN. It depends somewhat on the location. Our ground is very dry at Springfield; the soil is sandy, and we have not had one rot-out yet.

MR. KILLAM. I know, in some sections, two or three years is as long as they will last.

I should like to ask one question of Mr. Beck: Do you install these detector meters on the main line or on by-passes?

MR. BECK. On the main line.

PROCEEDINGS.

March Meeting.

Hotel Brunswick,
Boston, March 10, 1920.

Vice-President Brush in the chair.

The Secretary read applications for membership, approved, from: Marcel Pequegnat, Kitchener, Ont., superintendent of water commission; George E. Watters, New London, Conn., assistant engineer, water and sewer department; Leonard J. Hathaway, Jr., New Bedford, Mass., principal assistant to city engineer; Edwin H. Rogers, West Newton, Mass., city engineer; George C. Gensheimer, Erie, Pa., commissioner of water works, who were duly elected.

Mr. John C. Chase, for the committee appointed at the February meeting, presented the memoir of Frank L. Fuller.

Mr. X. H. Goodnough, for the committee appointed at the February meeting, presented the memoir of Frederic P. Stearns.

The Chairman. I believe that there are two charter members of this Association that are now honorary members and that these two charter members are with us to-day, — Messrs. Coggeshall and Hall. I will ask these gentlemen to stand, so that we can see what charter members look like.

[Messrs. R. C. P. Coggeshall and Frank E. Hall stand, amid great applause.]

The Chairman. I am going to ask Mr. Sherman, as chairman of our committee on Standard Specifications for Water Meters, to give you an outline of the progress that has been made to date.

Mr. Charles W. Sherman. *Mr. President and Gentlemen,* — I presume that many of you have thought the Committee on Meter Specifications was more or less of a joke. It has been in existence for four or five years, and up to the present time, has not produced anything to warrant its existence. I must confess that for a considerable part of the time I wondered myself whether it was a joke. I am now beginning to have not only hopes, but very considerable confidence that it is not by any means a joke.

Largely through the efforts of our fellow-member, Mr. Tilden, who became chairman of a Committee on Specifications of the Meter Manufacturers' Exchange, the manufacturers have gotten together and have discussed, and to a considerable extent standardized on paper, many of the most important points which a standard specification should cover, and on the basis of their conferences have gotten up specifications which they have submitted to our committee.

About the time that was being done, the American Association, wishing to forestall the possibility of having two competing specifications, also appointed a committee on meter specifications, with the idea of the two committees working jointly, or at least in parallel, so that their labors might be coördinated into one specification. .It seemed that that might best be accomplished by those two committees sitting jointly, practically as one committee. We have been so sitting for, I was going to say, twenty-four hours steadily previous to this meeting. We met yesterday afternoon and sat until very late in the evening, and again this morning from nine o'clock until the time of the Executive Committee meeting, and with the aid of the material which the Manufacturers' Exchange has put before us, and with what our members already had, have made such progress that we think it is going to be possible to draft a specification, discuss it with the manufacturers, and agree upon it in time to publish it in the June journals of the two associations, so that the American Association may take it up for discussion at its convention in June in Montreal, and this Association at its convention in September.

The specification, I should say, applies only to disk meters. We shall not attempt in our first report to cover anything more than that. In view of the very large percentage of disk meters compared to the total number of meters sold, we believe that we shall have made very considerable progress if we succeed in getting a specification for disk meters. Later we hope to come along with specifications for other types, but at first we will give you enough to consider in the one specification.

Mr. Reeves J. Newsom, commissioner of water supply, Lynn, Mass., read a paper on "Progress in Making an Established Water Works Modern and Efficient." Messrs. Caleb M. Saville, R. C. P. Coggeshall, Lincoln Van Gilder, and Charles W. Sherman participated in the discussion.

A paper on "Atlantic City High-Pressure Fire System" was read by Mr. Lincoln Van Gilder, engineer and superintendent, Water Department, Atlantic City, N. J. The discussion was participated in by Messrs. Caleb M. Saville, Richard D. Chase, and Vice-President Brush.

Mr. Fred O. Stevens, superintendent, water works, Weymouth, Mass., opened a discussion on "The Efficiency of Pipe-Jointing Compound as Compared with Lead."

The Secretary read a communication from Mr. E. E. Wall, water commissioner, St. Louis, Mo., on this subject.

Messrs. R. C. P. Coggeshall, Stephen H. Taylor, Lincoln Van Gilder, Frank A. McInnes, John Doyle, Frank J. Gifford, George McKay, Jr., A. E. Martin, Vice-President Brush, and Robert S. Weston took part in the discussion.

THE CHAIRMAN. At the meeting of the Executive Committee this morning it was voted to hold our annual convention this fall at Holyoke.

Adjourned.

FRANK LOUIS FULLER.

Frank Louis Fuller, the son of Hezekiah and Emeline (Jackson) Fuller, was born July 11, 1848, in that part of Needham which is now Wellesley and died at his home in Wellesley Hills, January 30, 1920. His death was very sudden and evidently from a heart trouble, for he had been in good health until a few minutes before his decease.

He graduated at the Mass. Institute of Technology in 1871, and immediately took up the profession of civil engineer, in which he was in active practice until the day of his death. While he had an office in Boston his activities extended throughout the state and into New Hampshire and Vermont as well.

Among his most important work was the original development or additions to the water-supply systems of Acton, Arlington, Marblehead, Methuen, Monson, Shirley, Waltham, Ware, Webster, West Brookfield, Winchendon, and Uxbridge, Mass.; Franklin, N. H., and Brattleboro, Northfield, and Woodstock, Vt.

He became a member of this Association on June 18, 1886, and was a very regular attendant at its meetings, participating freely in discussing the papers presented, which added materially to the information brought forth. He had also contributed several papers of interest.

He was a member of the American and Boston societies of civil engineers, the American Water Works Association, the American Public Health Association, and the Wellesley, the Congregational, and the Appalachian Mountain clubs. He was a member of the Wellesley Hills Congregational Church and had served as one of the deacons for many years. He was also a member of the Wellesley Water Board from 1887, being chairman of the board the greater portion of the time.

In 1881 he married Miss Julia L. Morrill, of Boston, who survives him. Mr. Fuller was an exceedingly genial and courteous gentleman and in his death the Association has lost a valuable member, who will be greatly missed, particularly by those with whom he has been intimately associated for a third of a century.

Francis C. Hersey, Jr.
John C. Chase.
George E. Winslow.